

Many asteroids are known to be non-spherical, as revealed by changes in their brightness as they rotate (lightcurves) and present varying cross-sections to view. Models of collisional evolution of the asteroid belt suggest that many of the larger asteroids are shattered "rubble piles," consisting of fragments bound together by gravity. If these assemblages are sufficiently weak, they should relax to equilibrium shapes that depend only on their spin periods and densities. Thus, if the shape of an asteroid is known, one might infer its density (constraining its composition) and internal structure.

Asteroids are too small for their shapes to be resolved directly by ground-based telescopes. The goal of our program is to use their brightness variations to derive shapes indirectly. This can be done by fitting mathematical models to a series of lightcurves obtained at different viewing geometries, i.e., at different points in their orbits. Over an eight-year period, we obtained hundreds of lightcurves for a selected sample of 26 asteroids. Model-fitting procedures allow us to derive their shapes; other information, e.g., pole orientations, spin directions, and phase functions are also obtained. Our observing program also included many "targets of opportunity"; we were able to derive rotation periods for 16 of these.

The derived shapes indicate some plausible candidates for equilibrium figures, but it is also clear that a majority of asteroids show large deviations from these idealized shapes. Analysis of the probable stresses within these asteroids shows that they require strengths of the order of 1 bar, which is quite weak compared with most geological materials. Their shapes can be explained if "rubble piles" do not consist only of small fragments, but include some large chunks as well.